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Panic Bars and Automatic Brakes

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UNITED STATES DEPARTMENT OF THE INTERIOR
Mining Enforcement and Safety Administration
Washington, D. C. 20240

U.S. Mining Enforcement and Safety Administration.

Informational Report, 1012

Panic Bars and Automatic Brakes

By Cecil E. Lester
Coal Mine Health and Safety, Mt. Hope, W. Va.

United States Department of the Interior
mesa
Mining Enforcement and Safety Administration

UNITED STATES DEPARTMENT OF THE INTERIOR
Rogers C. B. Morton, Secretary

Mining Enforcement and Safety Administration
James M. Day, Administrator

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PANIC BARS AND AUTOMATIC BRAKES

by

Cecil E. Lester[1]

ABSTRACT

This publication illustrates the need for the installation of panic bars that will permit rapid deenergization of equipment in emergencies and automatic emergency brakes on self-propelled electric face equipment used in coal mines. The publication contains drawings depicting actual fatal accidents that have occurred in underground coal mines which these safety devices could have prevented. Also included are drawings and technical data to be used to assist mine operating companies and equipment manufacturers in the design, installation, and maintenance of panic bars and automatic brakes.

INTRODUCTION

According to statistics contained in the files of Mining Enforcement and Safety Administration, 131 men were fatally injured in accidents involving self-propelled electric face equipment in the Nation's coal mines during the period January 1, 1970 - December 31, 1973. Electric face equipment is often operated in underground coal mines in areas where both horizontal and vertical clearance are extremely limited. A slight error in judgment on the part of the operator or a malfunction in the control system of the machine can cause the operator to be crushed before he has time to react. Properly installed panic bars and automatic emergency brakes can bring the machine to an immediate stop during these emergency situations, preventing death or serious injury to the operator.

Section 75.523 of the regulations (30 CFR 75) promulgated under the Federal Coal Mine Health and Safety Act of 1969 provides for an authorized representative of the Secretary to require devices that will permit the deenergization of face equipment quickly in the event of emergency.

On February 6, 1973, there was published in the Federal Register, mandatory safety standards pertaining to (1) the installation and performance requirements for deenergization devices, or panic bars as they are commonly called, that would deenergize self-propelled electric face equipment in the event of an emergency, and (2) the installation and performance requirements for automatic emergency brakes on rubber-tired, self-propelled, electric face equipment. The mandatory safety standards were made effective on March 1, 1973, and provided a schedule of time for the installation of panic bars as follows:

---

[1] Coal Mine Safety Specialist.

(1) On and after December 31, 1973, for self-propelled cutting machines, shuttle cars, battery-powered machines, and roof drills and bolters; and

(2) On and after March 31, 1974, for all other types of self-propelled electric face equipment.

The mandatory standards provided the same schedule of time periods for the installation of automatic emergency brakes on the same rubber-tired, self-propelled, electric face equipment.

Subsequent to the effective date of the standards, which was March 1, 1973, equipment manufacturers and Mining Enforcement and Safety Administration technicians encountered difficulties in developing performance specifications and guidelines for the manufacture and installation of panic bars and automatic brakes. Such specifications and guidelines were only developed a short time prior to December 31, 1973.

On December 19, 1973, there was published in the Federal Register a notice indefinitely suspending and postponing the dates of December 31, 1973, and March 31, 1974, for the installation of panic bars and automatic brakes. Notice was further given that a meeting and conference would be held January 29, 1974, at Bluefield State College, Bluefield, West Virginia, for the purpose of acquiring information and data with respect to the time needed to acquire, manufacture, and install deenergization devices and automatic emergency brakes upon self-propelled electric face equipment. Written and verbal information and data were submitted to MESA by equipment manufacturers, suppliers, operators, representatives of miners, and other interested persons, in response to the request. The notice also provided that after evaluation of the information and data received, new dates for compliance with the provisions would be established and published in the Federal Register.

The Mining Enforcement and Safety Administration, using available information and data, determined that deenergization devices (panic bars) could be installed without difficulty within approximately four months on self-propelled cutting machines, shuttle cars, battery-powered machines, and roof drills and bolters, and within approximately six months for all other types of self-propelled electric face equipment.

Therefore, on July 30, 1974, a notice was published in the Federal Register establishing new dates for the installation of the subject devices. These new dates are as follows:

(1) On and after December 15, 1974, for self-propelled cutting machines, shuttle cars, battery-powered machines, and roof drills and bolters; and

(2) On and after February 15, 1975, for all other types of self-propelled electric face equipment.

On and after these dates, panic bars will be required on all self-propelled electric face equipment that is not provided with a cab, in compliance with all applicable portions of Section 75.1710.

The panic bar is required to provide a ready means of deenergizing the tramming motors on the machine by:

(1) Mechanical actuation of an existing pushbutton emergency stopswitch,

(2) Mechanical actuation of an existing lever emergency stopswitch, or

(3) The addition of a separate electro-mechanical switch assembly.

The existing emergency stopswitch or additional switch assembly shall be actuated by a bar or lever which shall extend a sufficient distance in each direction to permit quick deenergization of the tramming motors of self-propelled electric face equipment at all locations from which the equipment can be operated.

Moving the actuating bar or lever not more than 2 inches as a result of the application of not more than 15 pounds of force caused by contact with any portion of the equipment operator's body at any point along the length of the actuating bar or lever shall cause deenergization of the tramming motors of the self-propelled electric face equipment.

Self-propelled electric face equipment is often operated in areas of coal mines where both vertical and horizontal clearances are extremely limited. Operators of such equipment are in constant danger of being pinned, squeezed, or crushed against the mine roof, ribs, roof support or other mining equipment. An error in judgment on the part of the operator, or a malfunction in the machine control system, can, and has, often caused death or serious injury to the operator before he has time to react.

A few of the past accidents that have resulted in coal mine fatalities will be illustrated and discussed in the following pages. Many of these fatal accidents could have been prevented by the installation of panic bars and automatic emergency brakes on the equipment.

The purpose of this discussion is to provide a good understanding of just what panic bars and automatic brakes are intended to accomplish, information which will be extremely useful to those having responsibility for the design, installation, and maintenance of these devices.

The shuttle car operator who lost his life in the accident illustrated in figure 1 normally operated the opposite standard shuttle car which was being repaired at the time of the accident. At the time of the accident he

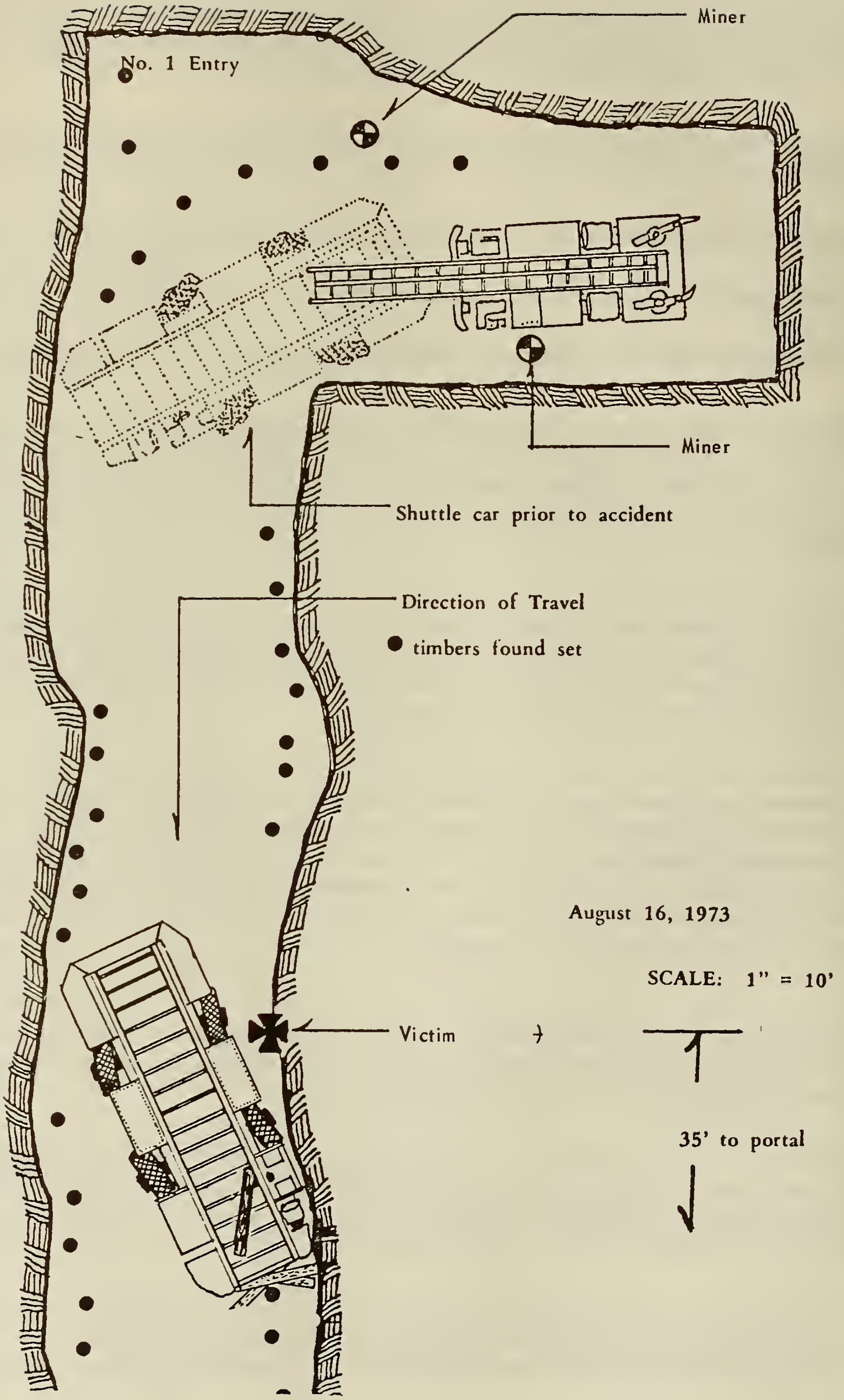

FIGURE 1. - Fatal coal mine haulage accident involving malfunctioning of shuttle car controls.

was relieving the other shuttle car operator for lunch. This shuttle car was less than 1 year old at the time of the accident. In figure 1 the shuttle car is under the loading boom. Just as the loader operator started loading the shuttle car, suddenly, without any warning and without any action on the part of the operator, trammed at maximum speed away from the loader, toward the surface. The shuttle car, out of control, dislodged several roof support posts along the left rib, then veered toward the right rib and continued along the rib for approximately 10 feet before the rib and dislodged posts stopped its progress. The shuttle car operator was crushed against the rib and was killed. It seems obvious that if a panic bar had been installed on this shuttle car, and assuming that the operator was familiar with its use and purpose, the instant he realized that he was not in full control of the shuttle car, he would have slapped the panic bar, deenergized the traction motors and applied the automatic brakes, and brought the machine to a safe stop. The investigation revealed that a short circuit in the control wiring in the master station caused the shuttle car to tram out of control.

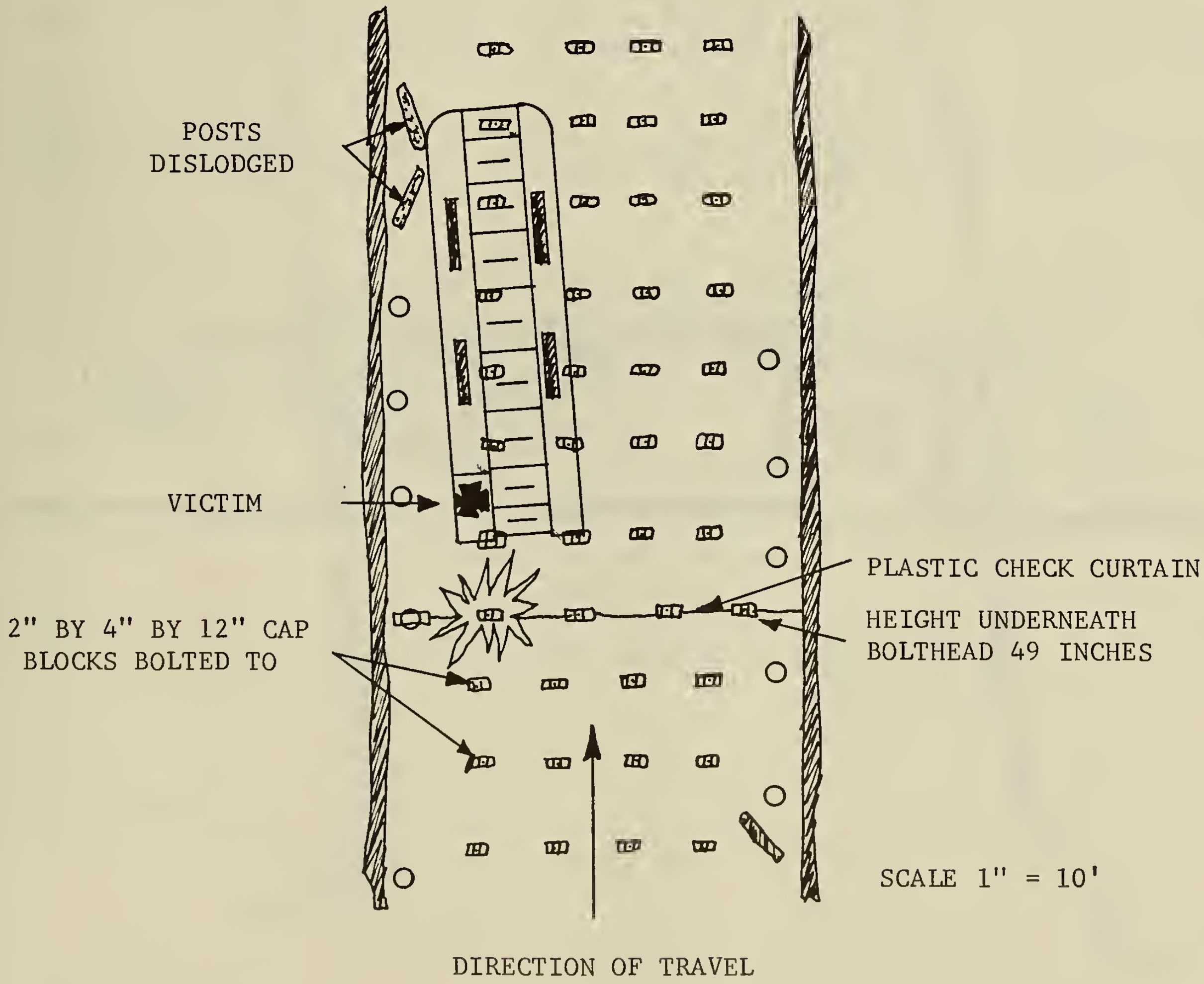

FIGURE 2. - Fatal haulage accident involving shuttle car passing through check curtain.

There have been several serious accidents that have occurred involving shuttle car drivers passing through check curtains. In this accident, shown in figure 2, the shuttle car was proceeding toward the face through a check curtain.

When driving a shuttle car through a check curtain, there is a short period of time, while the curtain is sliding over the operator's head, when he cannot see anything. In the accident, illustrated by figure 3, the thickness of the coal seam in the area where the accident occurred was 36 inches, which provided 4 inches of clearance over the shuttle car. The operator became entangled in the check curtain and was dragged from the shuttle car and his head was crushed between the shuttle car and the mine roof. Even in a situation of this type, there is a short space of time when the man realizes he is in trouble and could reach out, even with the curtain in his face, and slap the panic bar and stop the machine.

Figure 4 illustrates a similar accident, except the investigation revealed that the steering mechanism and the brakes on this shuttle car were also defective. In fact, the brakes were completely inoperative.

Two similar accidents are shown in figures 5 and 6 in which each shuttle car operator became entangled in a check curtain and was pulled from his seat and crushed. In these accidents the operators were crushed against the coal rib.

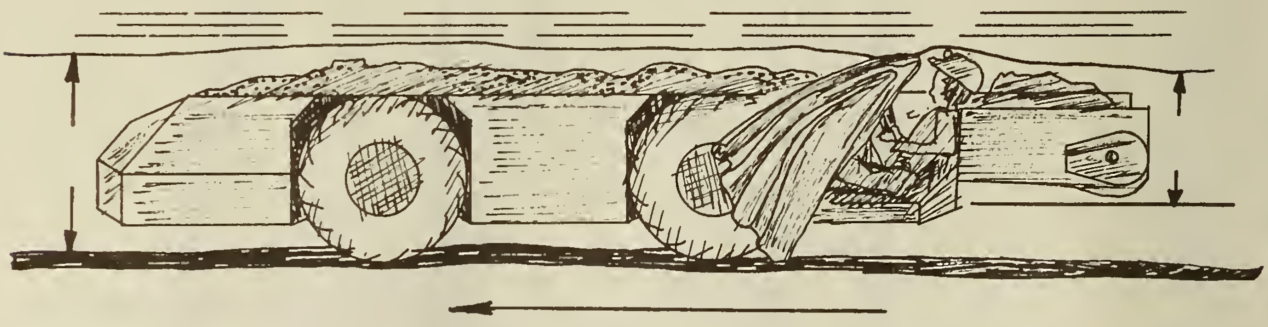

FIGURE 3. - Shuttle car operator passing through check curtain.

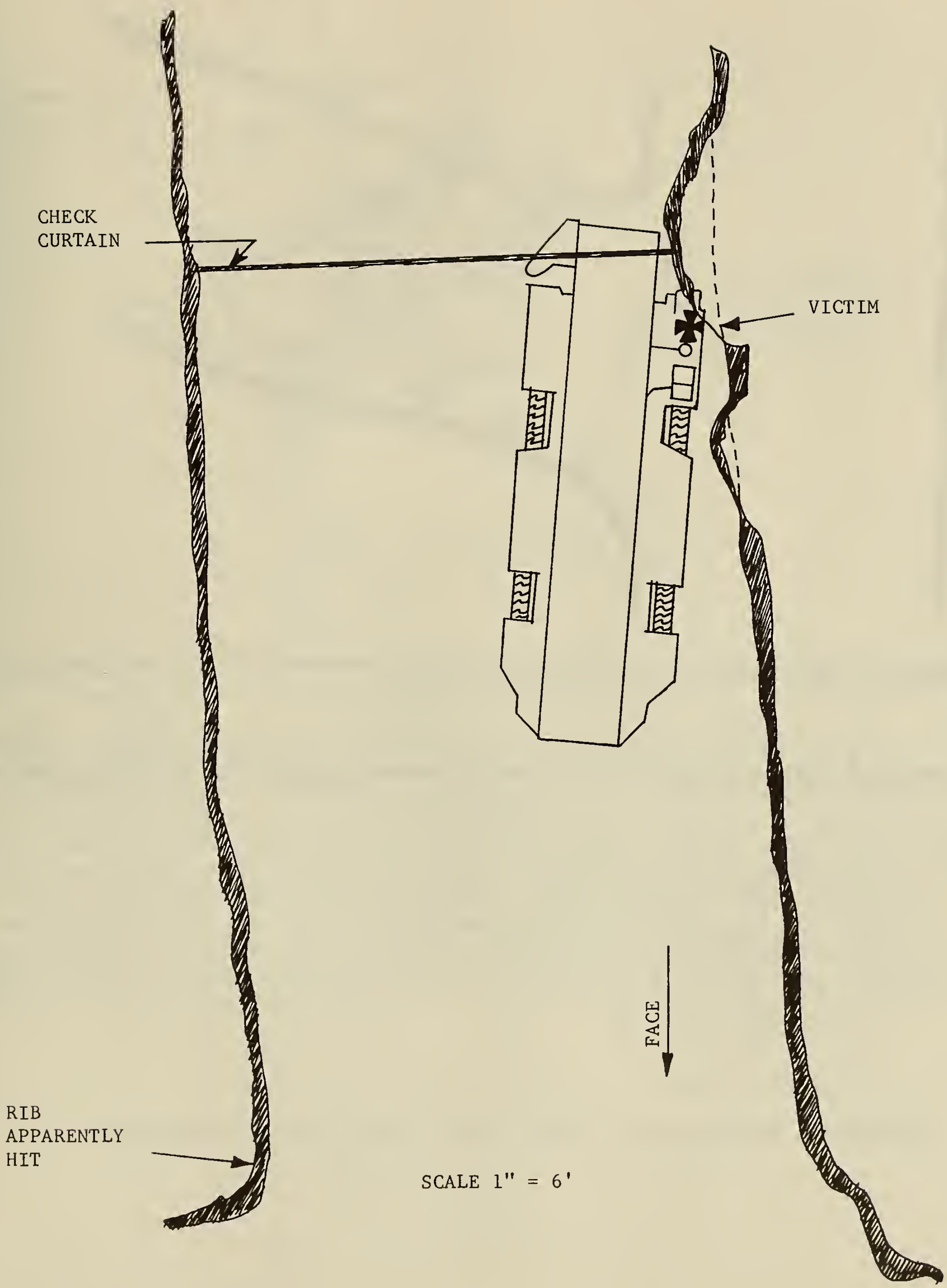

FIGURE 4. - Fatal haulage accident involving operation of shuttle car with defective brakes and steering.

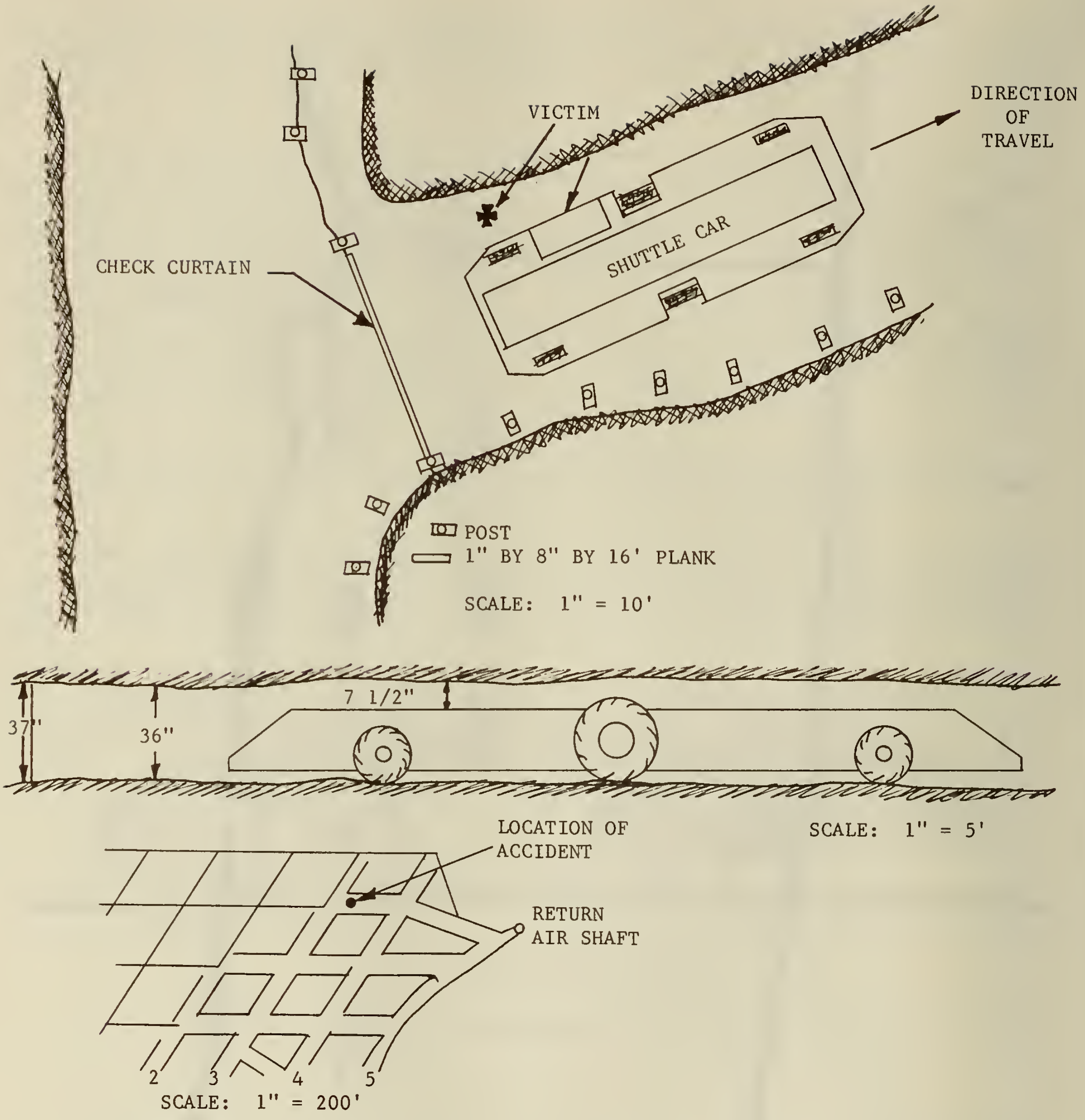

FIGURE 5. - Fatal haulage accident in which operator is dragged from shuttle car.

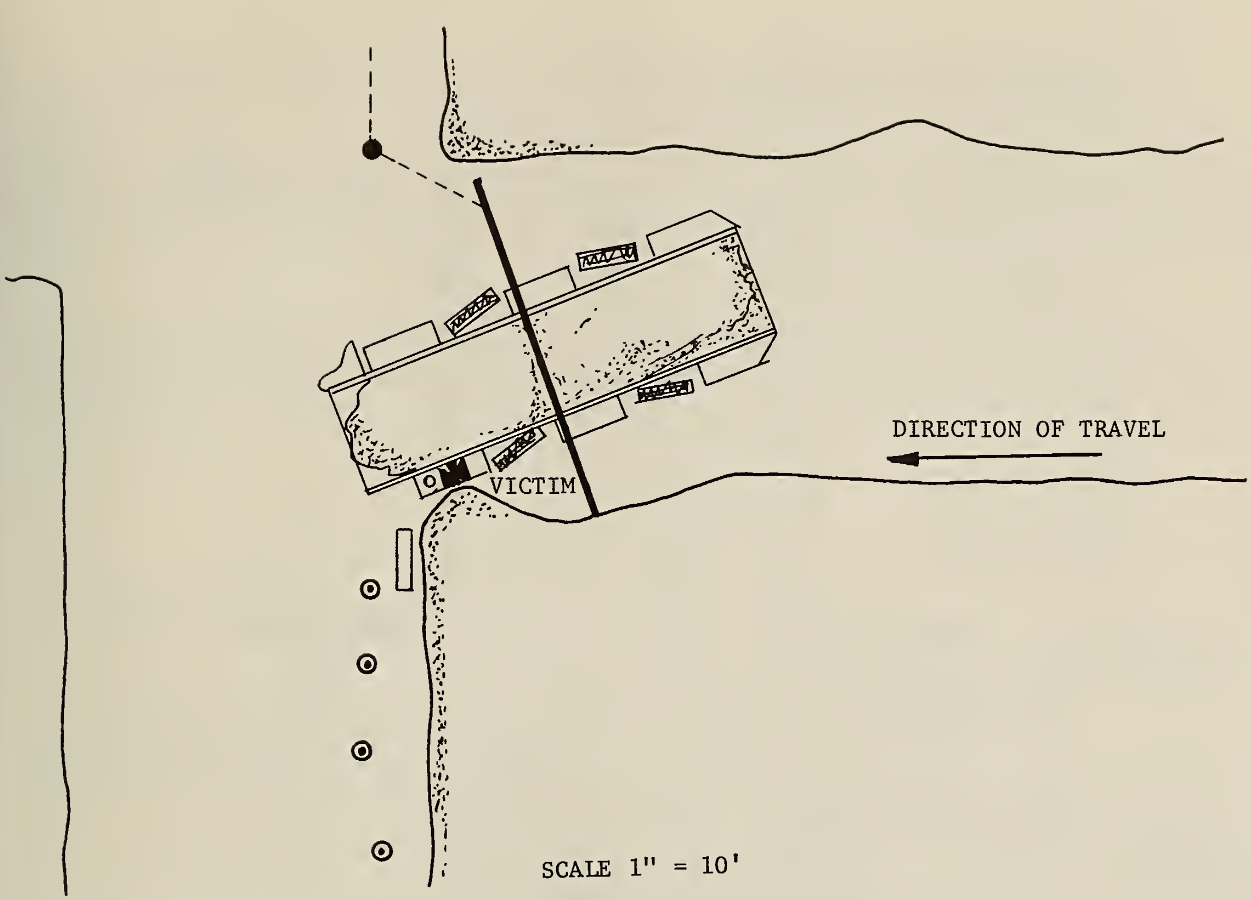

FIGURE 6. - Fatal haulage accident in which shuttle car operator is crushed against coal rib.

In this accident, as illustrated in figure 7, the shuttle car operator parked the shuttle car on a 9.5 percent grade. As he started to get off the shuttle car, the car started to drift backward. He tried to stop the car with his foot brake but a closed valve had been inserted into the hydraulic line for use as a parking brake; therefore, the valve would have been required to be open before the brake could be applied. In the excitement, the operator did not think to open the valve and the shuttle car ran 33 feet and crushed another miner to death against the power center. This illustrates a need for a positive acting parking brake.

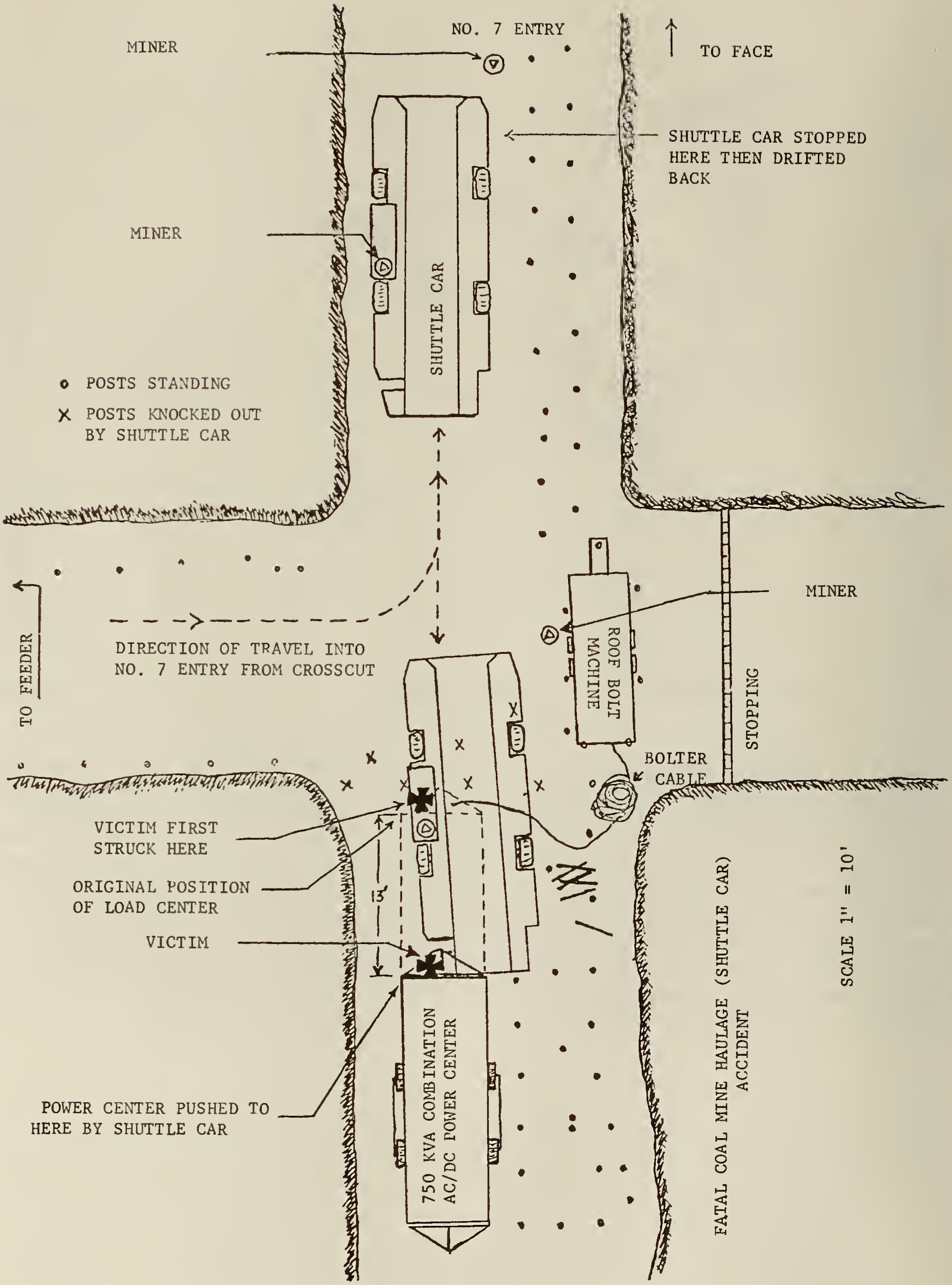
MINER
NO. 7 ENTRY
TO FACE
SHUTTLE CAR STOPPED HERE THEN DRIFTED BACK
MINER
SHUTTLE CAR
o POSTS STANDING
X POSTS KNOCKED OUT BY SHUTTLE CAR
MINER
ROOF BOLT MACHINE
TO FEEDER
DIRECTION OF TRAVEL INTO NO. 7 ENTRY FROM CROSSCUT
STOPPING
BOLTER CABLE
VICTIM FIRST STRUCK HERE
ORIGINAL POSITION OF LOAD CENTER
13'
VICTIM
FATAL COAL MINE HAULAGE (SHUTTLE CAR) ACCIDENT
SCALE 1" = 10'
POWER CENTER PUSHED TO HERE BY SHUTTLE CAR
750 KVA COMBINATION AC/DC POWER CENTER

FIGURE 7. - Fatal accident involving shuttle car drifting down steep grade.

Figure 8 shows another malfunctioning shuttle car causing a fatality. The opposite standard shuttle car on the right was stopped in the right crosscut to allow the standard shuttle car to proceed to the section dumping point. As the standard shuttle car proceeded toward the dumping point, the opposite standard shuttle car suddenly lurched forward out of control and struck the operator's deck of the standard shuttle car, crushing the operator. The footswitch controlling the tram motors stuck in the forward position.

Figure 9 illustrates another fatal accident in which a footswitch stuck in the run position and the brakes were defective. The shuttle car was approaching the continuous miner and the footswitch stuck in position. The shuttle car ran under the end of the miner boom, crushing the operator.

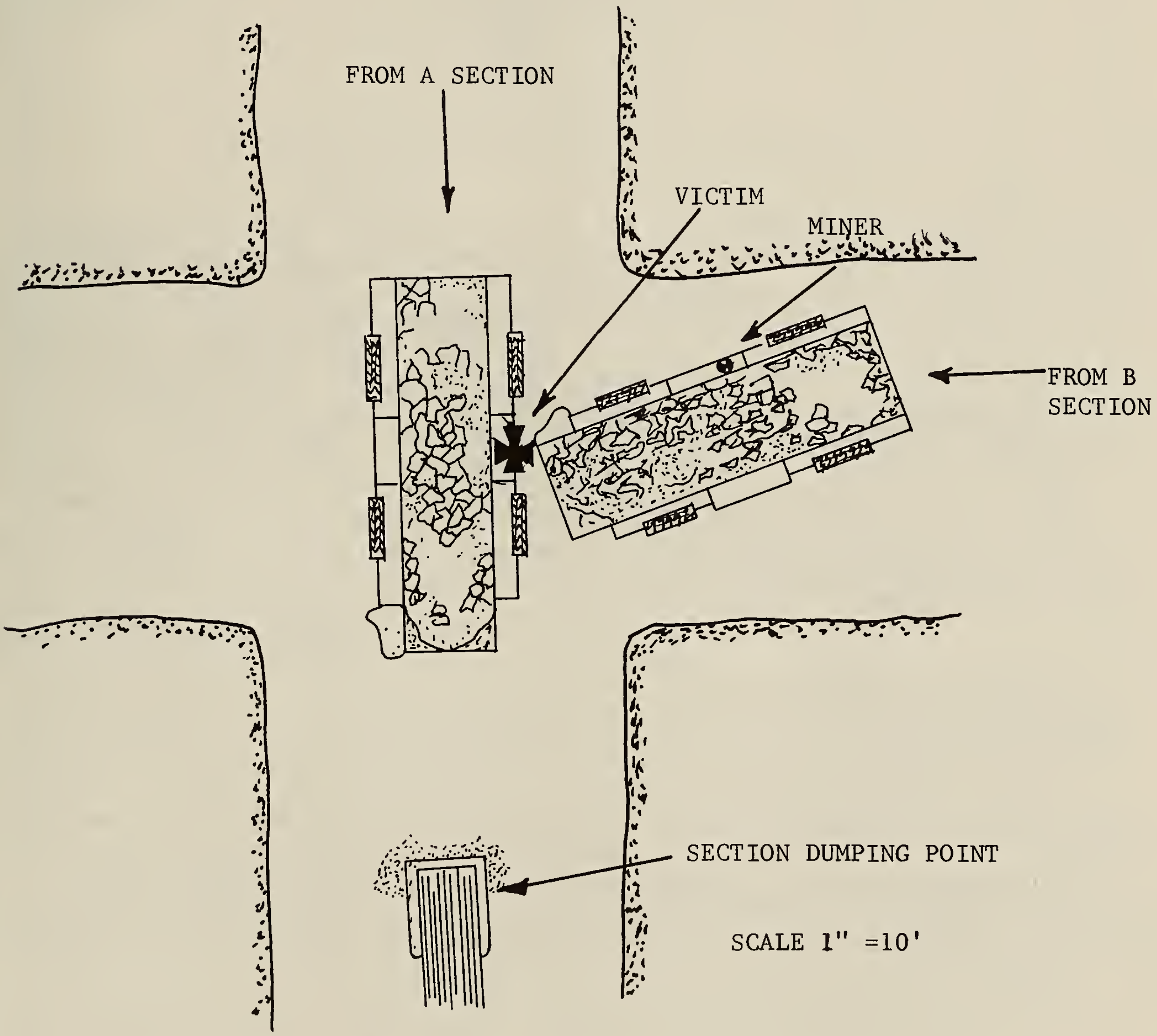

FIGURE 8. - Fatal haulage accident involving shuttle car with malfunctioning controls.

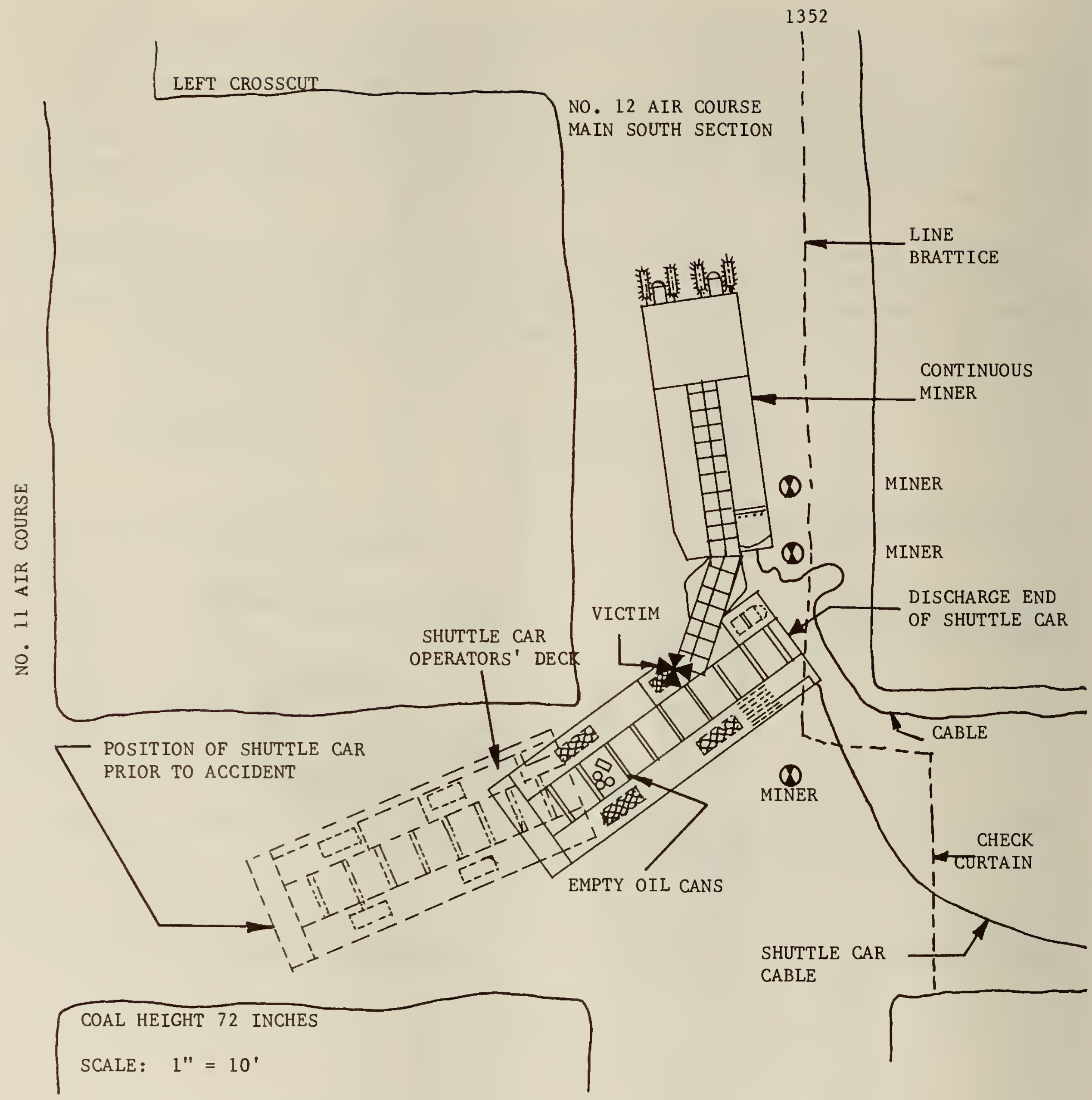

FIGURE 9. - Fatal haulage accident involving shuttle car with malfunctioning controls.

Panic bars should be installed on shuttle cars in the manner shown in figure 10. In many of these fatal accidents there is ample time for the operator to operate a panic bar such as this and stop the machine, preventing the accident.

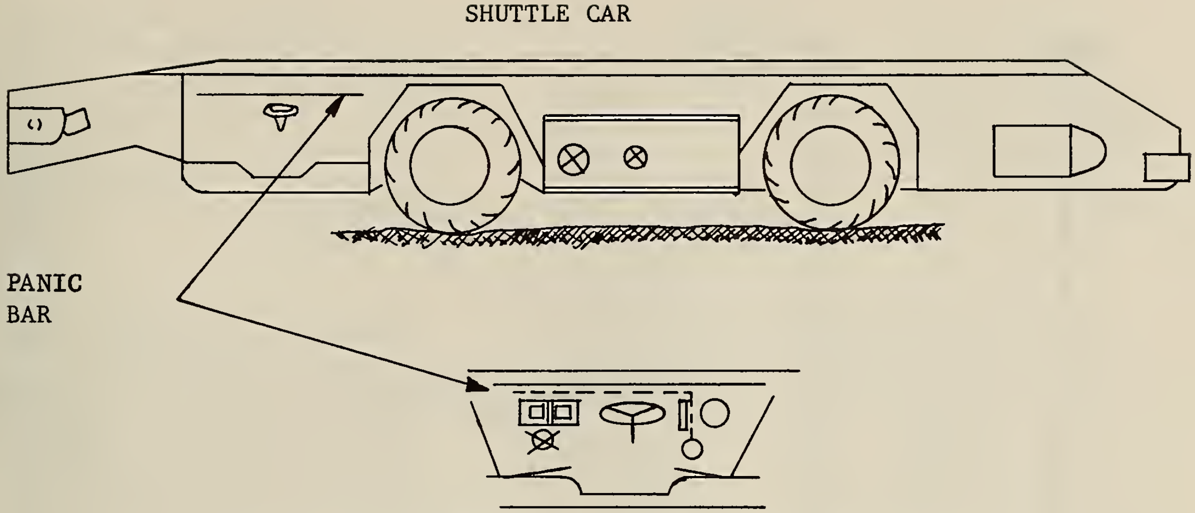

FIGURE 10. - Proper location of panic bar on shuttle car.

A 10-ton shuttle car traveling 5 miles per hour will, of course, coast several feet before stopping after the tram motors are deenergized. In many cases, although the tram motors have been deenergized, the shuttle car would coast into a rib or other obstruction and crush the operator. This is one reason for requiring automatic emergency brakes on self-propelled, rubber-tired equipment. When the operator must make a panic stop, he would only have to slap the panic bar causing the tramming motors to be deenergized and the automatic emergency brake to be immediately applied, bringing the vehicle to a safe stop in the shortest possible time. Of course, the vehicle would still travel a short distance even if equipped with automatic brakes, but in the restricted space of a coal mine in which such equipment is operated, a few inches often means the difference between life and death. Such abrupt stops will certainly place a severe strain on the gear train and drive shafts, but panic stops should only be made in emergency situations. At other times, the service brake should be used.

This accident, as shown in figure 11, involved a rubber-tired coal-cutting machine. The machine was traveling toward the face and the operator stopped at the check curtain so that it could be raised to prevent the cutter bits from catching on the curtain. The machine helper was riding in the right-hand deck. When the operator stopped the cutting machine near the check curtain, the tram transmission lever jumped out of gear, allowing the machine to start moving backward down a 3-1/2-percent grade. This machine had been equipped with a footbrake, but was so badly worn that it was useless. The operator normally stopped the machine in such situations by dropping the cutting boom to the mine floor. However, he could not find the cutter boom control lever in time and the machine ran backward, crushing the machine helper against the rib. Obviously, a good emergency braking system could have prevented this fatality.

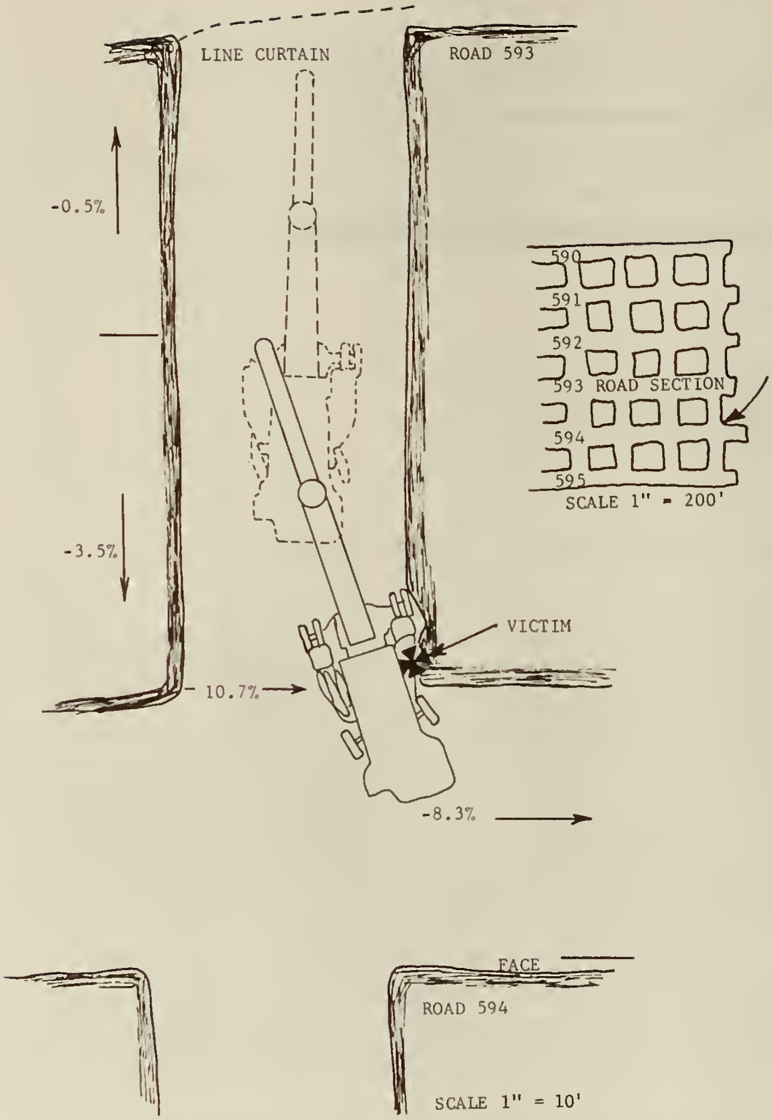

FIGURE 11. - Fatal machinery accident involving rubber-tired cutting machine drifting down steep grade.

Panic bars should be installed on rubber-tired cutting machines in the manner shown in figure 12. One panic bar should be installed at all locations from which the machine can be operated.

A loading machine operator was killed in the accident illustrated in figure 13. He had finished loading out a cut of coal in one entry and was tramming the loading machine to the next entry when the accident occurred. The loader operator was maneuvering the machine through a check curtain without raising the curtain and the head of the machine contacted the inby rib of the crosscut. As the operator manipulated the tram controls to maneuver the head of the machine away from the rib, he was caught and crushed between the rib and the machine. A simple panic bar would almost certainly have saved this man's life. A properly-installed panic bar would have been the first part of the machine to have touched the operator's body and 15 pounds of force would have stopped the traction motors and prevented any injury to the operator.

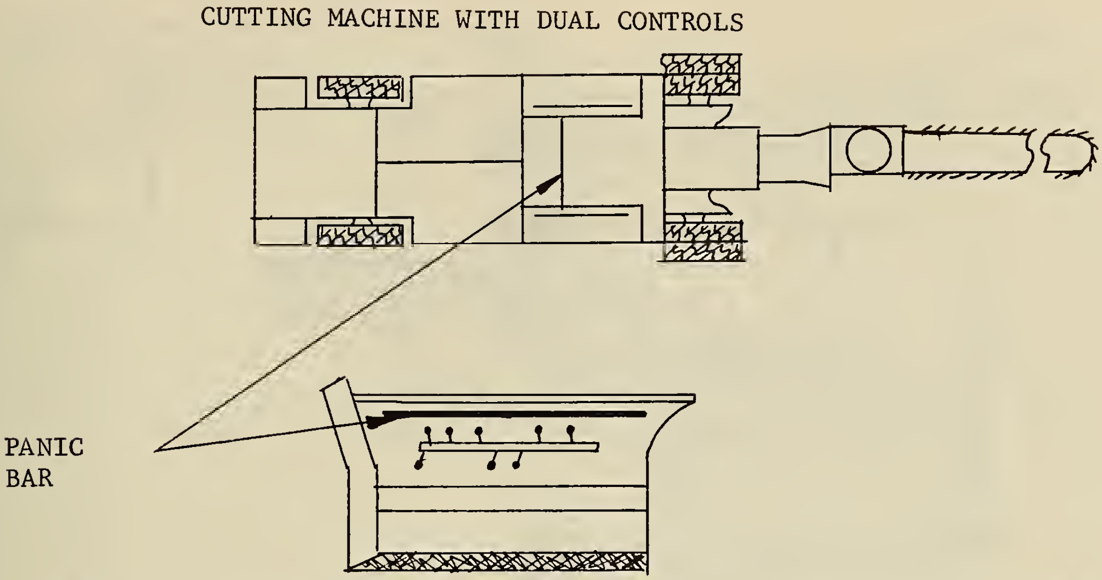

FIGURE 12. - Proper location for panic bar on cutting machine with dual controls.

Figure 14 illustrates a similar accident. The loader operator was cleaning up loose coal, that had been shot off the ribs of the last line of crosscuts, to provide clearance for the equipment to travel. The operator was cleaning the right rib when he became pinned between the frame of the loading machine and the rib. The operator managed to place the tram control levers in the neutral position before he lost consciousness. The crushing injuries he sustained to his chest were so severe that he never regained consciousness. Notice the position of the operator when the accident occurred.

Figure 15 shows why the panic bar is required to be so long on machines of this type. The operator is required to walk or crawl beside the machine. The panic bar must extend a sufficient distance in each direction so that the panic bar will contact the operator's body in situations like these and cause the traction motors to be stopped without any action on the part of the operator.

A properly designed panic bar, installed on these two machines, would have prevented these accidents and all other similar accidents that have occurred.

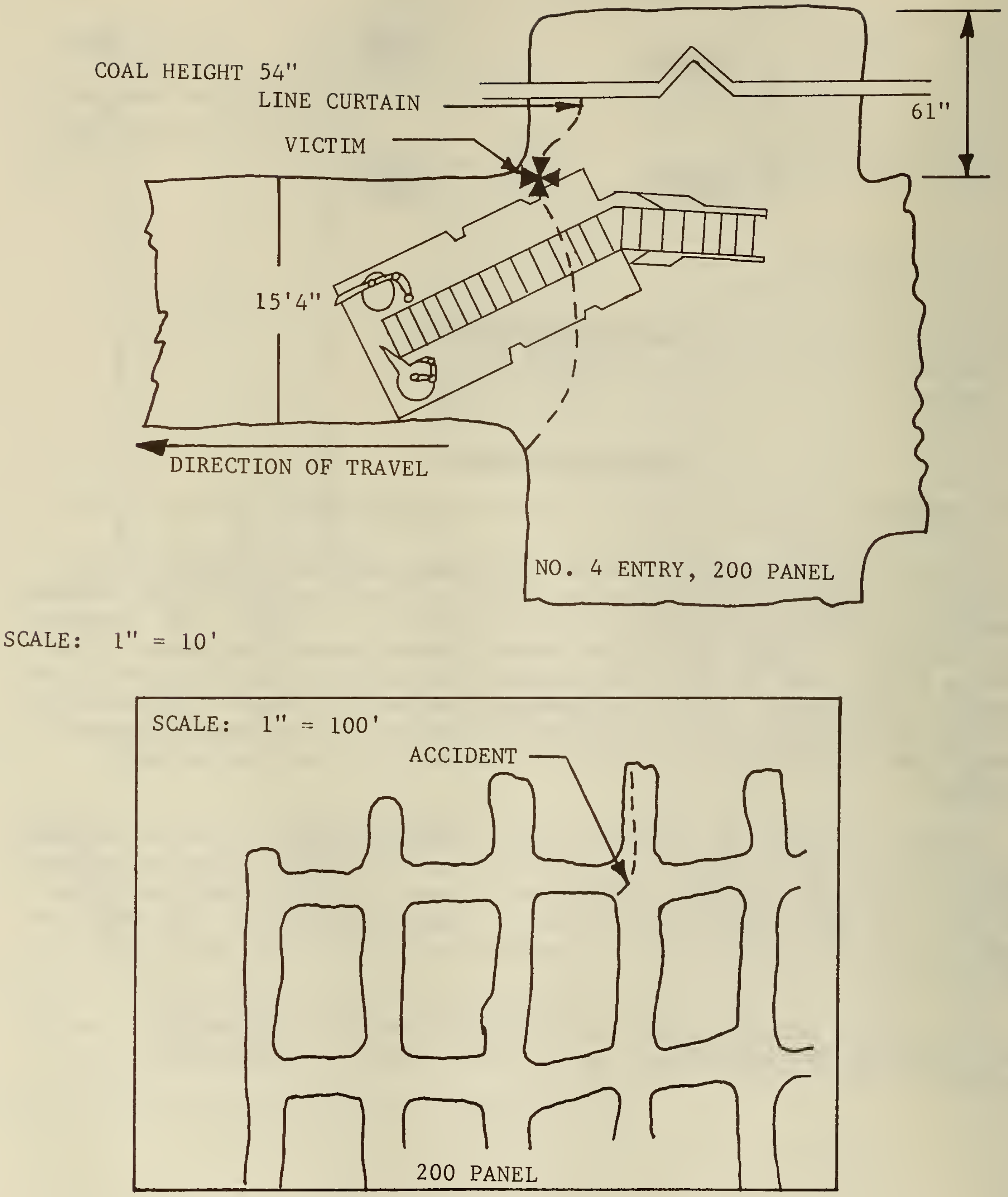

FIGURE 13. - Fatal machinery accident involving operation of loading machine.

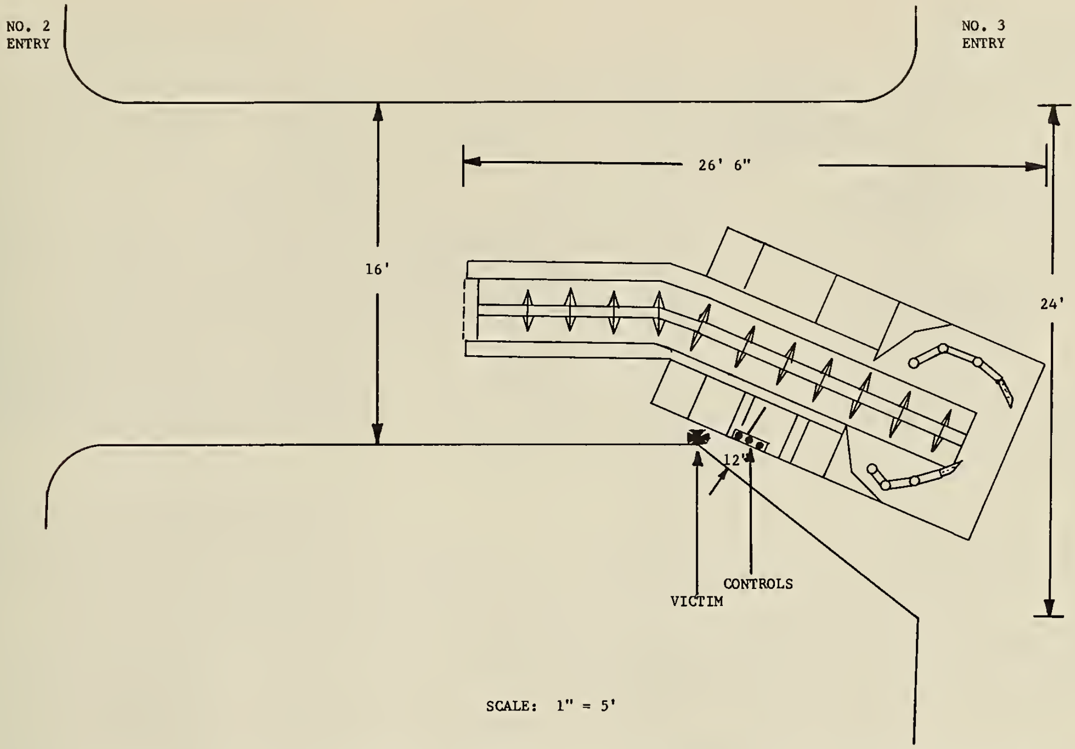

FIGURE 14. - Fatal machinery accident involving operation of loading machine.

IF AN OPERATOR OF A COAL MINE OR EQUIPMENT MANUFACTURER WISHES TO USE A METHOD OF DEENERGIZATION OF THE EQUIPMENT OTHER THAN THE PANIC BAR OR LEVER METHOD, HE SHALL APPLY TO ASSISTANT ADMINISTRATOR--TECHNICAL SUPPORT, MINING ENFORCEMENT AND SAFETY ADMINISTRATION, WASHINGTON, D.C. 20240, FOR APPROVAL OF SUCH DEVICE PRIOR TO INSTALLATION.

LOCATIONS

LOADING MACHINE

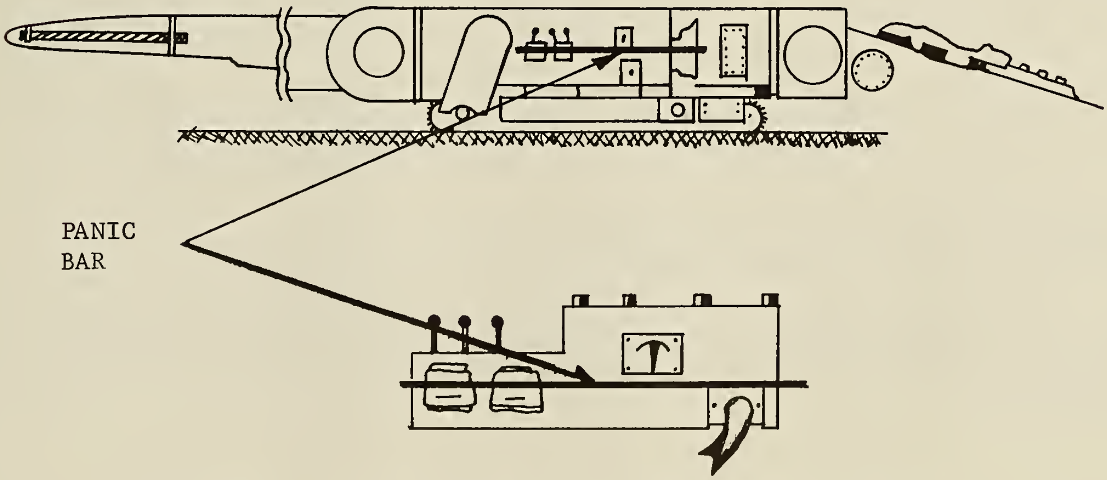

FIGURE 15. - Proper location of panic bar on loading machine.

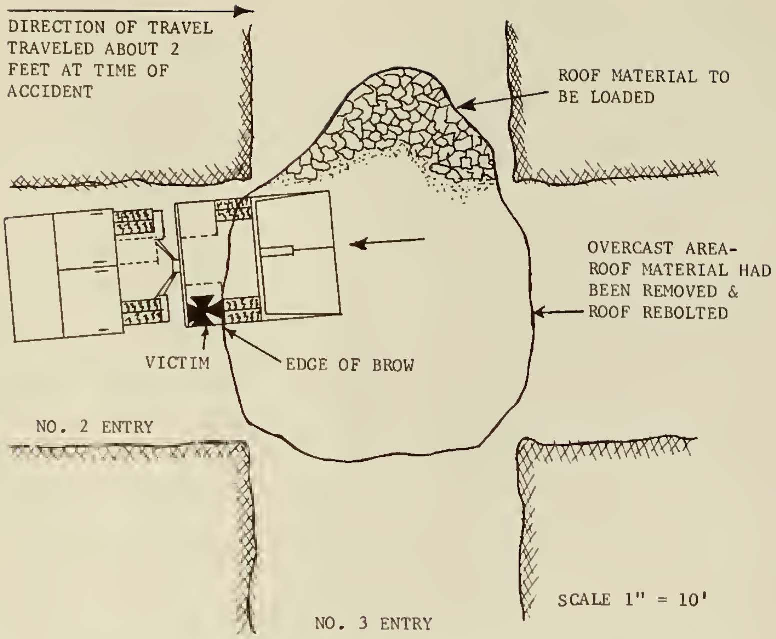
DIRECTION OF TRAVEL
TRAVELED ABOUT 2 FEET AT TIME OF ACCIDENT
ROOF MATERIAL TO BE LOADED
OVERCAST AREA-ROOF MATERIAL HAD BEEN REMOVED & ROOF REBOLTED
VICTIM
EDGE OF BROW
NO. 2 ENTRY
NO. 3 ENTRY
SCALE 1" = 10'

FIGURE 16. - Fatal accident involving operation of battery-powered coal scoop.

Figure 16 illustrates an accident in which a battery-powered scoop operator was killed. He was removing rock that had been shot down for an overcast. The operator was crushed between the machine and overhanging brow when the vertical clearance changed abruptly from 6 feet to 37 inches. The brakes were defective at the time of the accident.

Panic bars (actuating bars) should be installed on a battery-powered scoop in the fashion shown in figure 17. Notice that there is a bar on each side of the operator. This machine, of course, operates in both directions and the operator could be forced in either direction. Also, he should have a panic bar readily available to him regardless of the direction of travel or regardless of the direction the operator is facing.

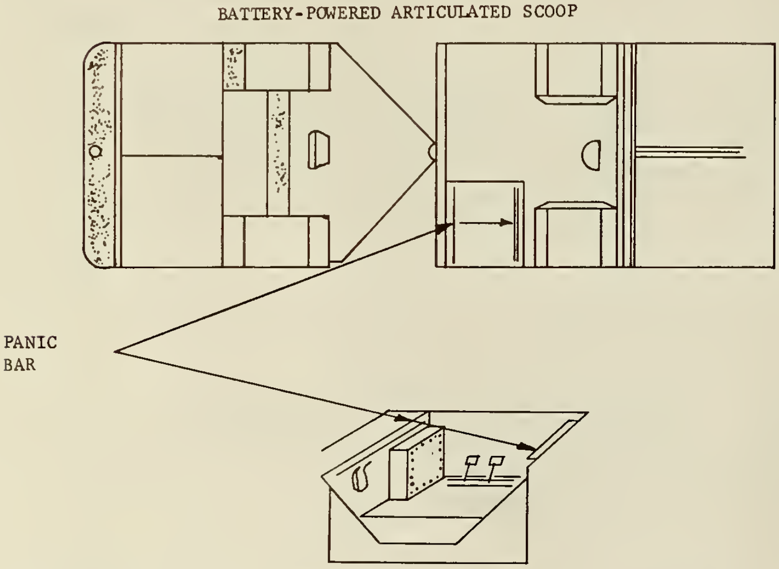

FIGURE 17. - Proper location of panic bars on battery-powered articulated scoop.

In this accident, as shown in figure 18, the operator was driving the smaller tractor down the entry when the tramming contactors became welded together and he could not stop the tractor. The larger vehicle is a personnel carrier in which four men were sitting, waiting to be transported to the surface. The operator shouted for the men to jump from the larger vehicle, which they all did safely. The smaller tractor ran under the personnel carrier, crushing the operator.

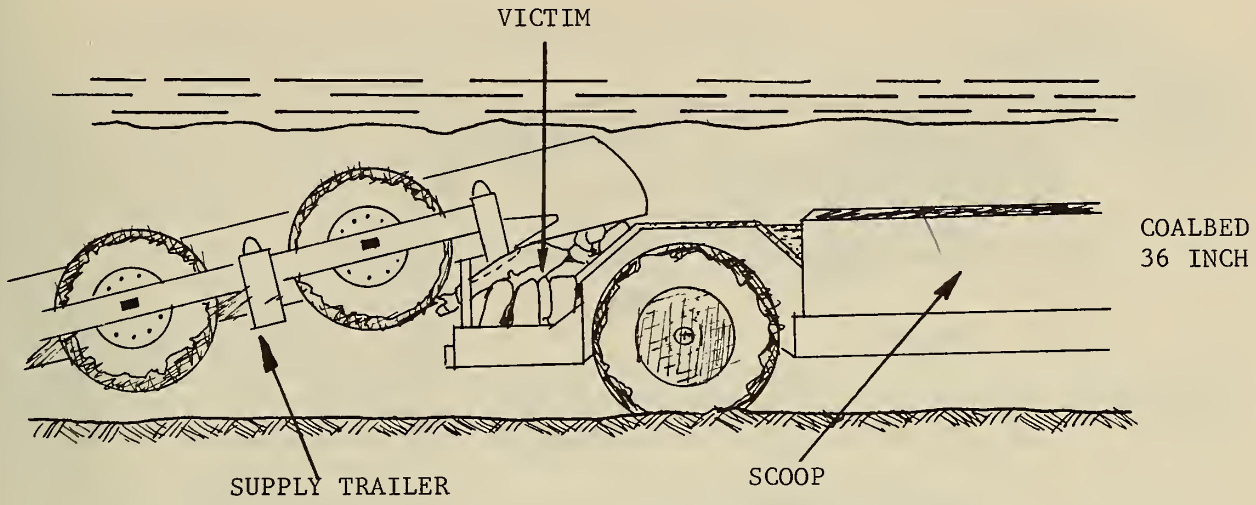

FIGURE 18. - Fatal accident involving malfunctioning controls on battery-powered tractor.

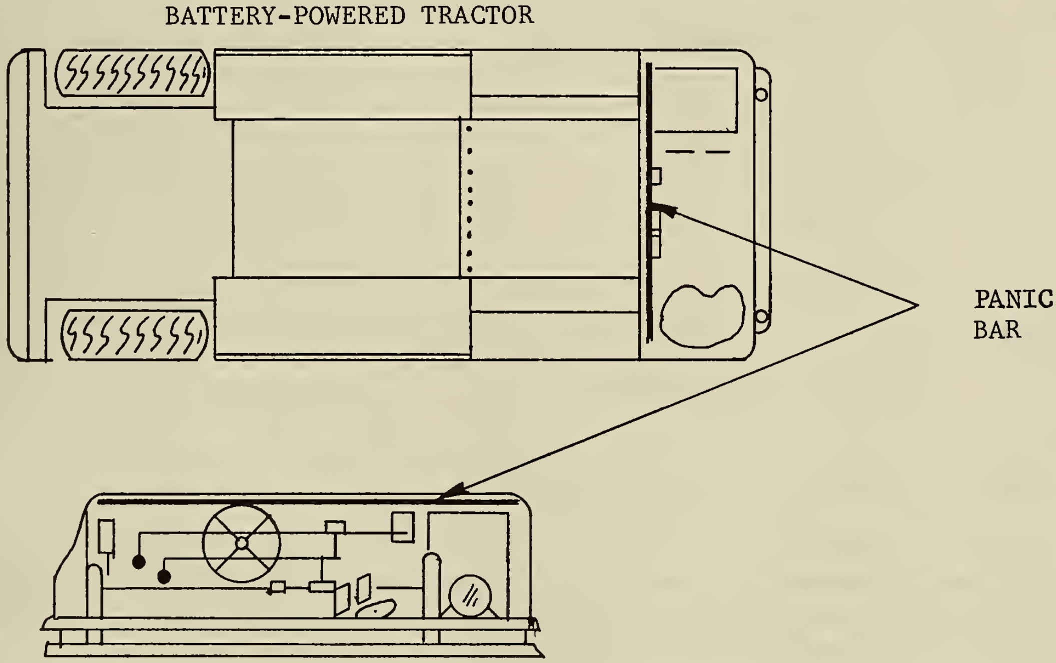

FIGURE 19. - Proper location of panic bar on battery-powered tractor.

Panic bars should be installed on battery-powered tractors in the manner illustrated in figure 19. There have been several accidents in which the operator has been rolled between the tractor and the mine roof. If the panic bar is installed as high as possible, the operator's body would contact the panic bar if he should be rolled over the machine.

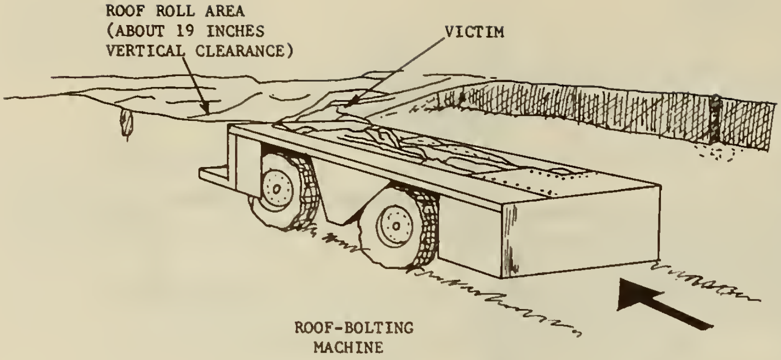

FIGURE 20. - Fatal machinery accident involving operation of roof bolting machine.

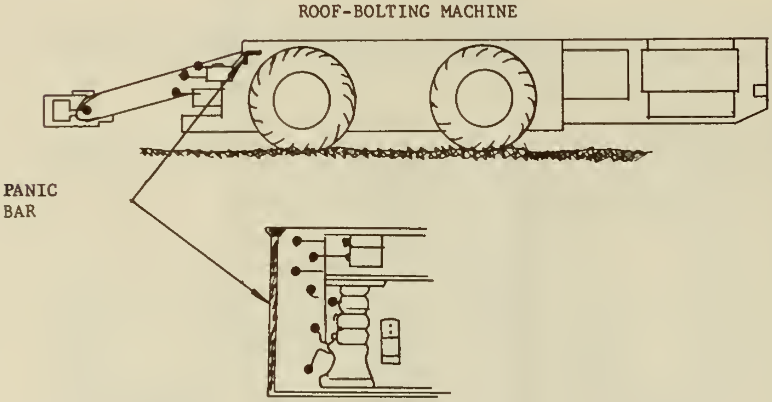

FIGURE 21. - Proper location and configuration of panic bar on roof bolting machine.

Rubber-tired roof-bolting machines also require panic bars. In the accident shown in figure 20, the operator was drilling blastholes to blast off a roof roll. He was attempting to maneuver the machine as far as possible under the edge of the roof roll and one of the hydraulic tram levers became fouled against the roof, causing one set of traction wheels to remain in forward motion. The operator was working in about 19 inches vertical clearance and when the tram lever became jammed, he attempted to deenergize the machine by depressing the stop button located on the opposite side of the machine. As the operator attempted to reach over and around the front end of the machine, he was caught by the forward motion of the machine and his head and neck were pinned between the machine and the roof roll. Although he was fatally injured during the accident, he managed to operate the control switch which removed power from the machine.

A properly designed panic bar such as the one shown in figure 21 would provide an easily accessible means to remove power from a roof-bolting machine or if the machine contacted his body, would automatically stop the machine with no action on the part of the operator.

Figure 22 shows a panic bar installed on a continuous miner.

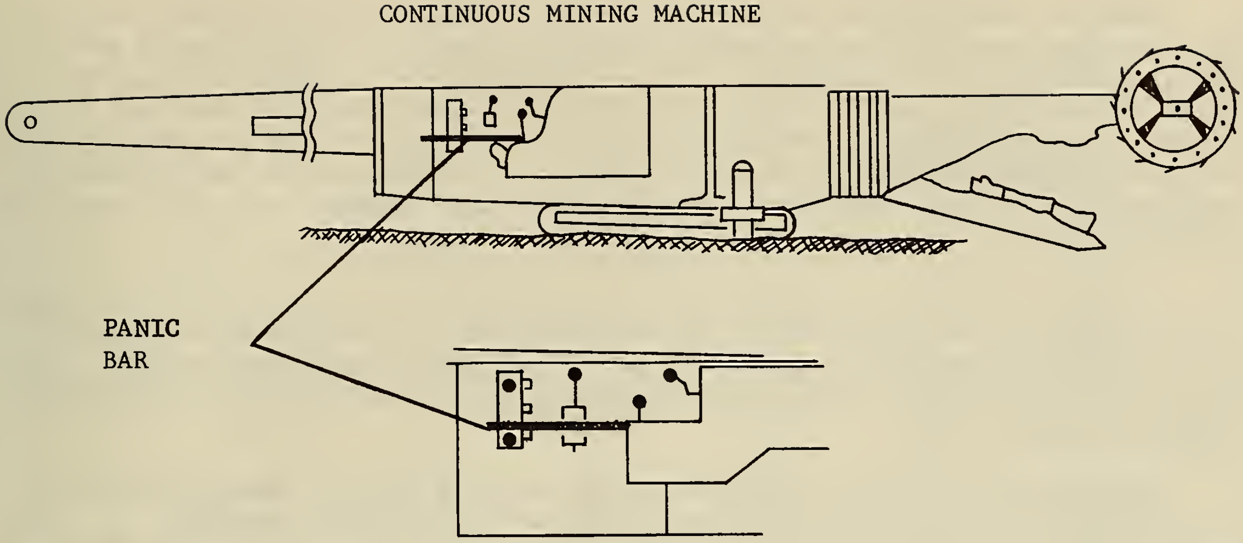

FIGURE 22. - Proper location of panic bar on continuous mining machine.

The sketches of panic bars that have been used in this paper were taken from a technical paper entitled "Guidelines for the Design and Installation of Devices for Deenergization of Self-Propelled Electric Face Equipment" which contains specifications for the design and installation of deenergization devices. Copies of the technical paper are available at all MESA district offices and can be used as a guide and aid for the installation of the panic bars. Devices that are identical to those shown by the drawings and illustrations contained in the technical paper will be considered to be in compliance with the requirements of Sections 75.523-1 and 75.523-2 and require no letter of acceptance. If an operator desires to install a device of a configuration different than those depicted in the technical paper, or if technical assistance is needed, the operator should contact the MESA Coal Mine Health and Safety District Office and request an examination of the device to assure compliance. MESA electrical engineers and electrical inspectors will provide technical assistance upon request by mine operators. At the coal mine operator's request, MESA personnel will also inspect the device installed on the machine. Although an approval plate or label will not be issued by MESA, nor will such a plate or label be required, if a device meets or exceeds the requirements of Sections 75.523-1 and 75.523-2, the operator, at his request, will be advised in writing of the acceptability and determination by MESA of compliance with the standards.

Equipment manufacturers may have panic bar designs for new equipment evaluated by MESA prior to manufacture, installation, and delivery to a customer. To obtain such evaluation, the manufacturer shall furnish to Mining Enforcement and Safety Administration, Approval and Testing, Pittsburgh Technical Support Center, 4800 Forbes Avenue, Pittsburgh, Pa. 15213, drawings or specifications that depict or describe the panic bar installation, including the equipment type and model for which the panic bar is designed, the relationship of the bar to the equipment operator's position, the operating range of the bar, the location of the bar, the distance the bar moves before deenergization occurs, and the force required to operate the bar.

Approval and Testing, Pittsburgh Technical Support Center, will evaluate the data and designs provided and notify the manufacturer if tests or additional information is required. If the installed device meets the requirements of Sections 75.523-1 and 75.523-2, the equipment manufacturer will receive a letter to that effect. A copy of the letter should be provided by the manufacturer to each purchaser of a machine equipped with the evaluated device. No approval plate or label will be issued by MESA, nor will such a plate or label be required.

A new evaluation will be required if there is any change in the equipment type and model, the relationship of the panic bar to the equipment operator's position, the operating range of the panic bar, the location of the bar, the distance the bar moves before deenergization occurs, or the force required to operate the panic bar.

Information and data presented at the meeting held on January 29, 1974, at Bluefield, W. Va., also disclosed that Section 75.523-3 does not contain sufficient technical data to permit the development of specifications and design criteria for automatic brakes, does not adequately specify stopping criteria, and that difficulty will be encountered in retrofitting older equipment with automatic brakes within the same period of time as might be accomplished for new equipment. Therefore, the dates specified in Section 75.523-3 for the installation of automatic brakes were suspended and amendments and revisions to that section, which will more adequately provide specifications and design criteria for automatic brakes, stopping distances, and time periods for retrofitting older equipment, are being prepared and will be published in the Federal Register in the near future. The performance requirements will be essentially the same but will be written in more detail to facilitate design, installation, and approval of these devices. In general, the requirements for automatic emergency brakes will be as follows:

1. The brake shall automatically engage when either

    (a) The panic bar is activated, or
    (b) When electric power is removed from the machine.

2. When the panic bar is activated, the brake shall bring the equipment to a complete stop in the distances shown on the bottom curve as illustrated in figure 23. When electric power is accidentally removed from the machine, the brake shall bring the machine to a safe stop before steering power is lost.

3. The brake shall bring the equipment to a complete stop in the distances shown on the upper curve of figure 23 with the brakes adjusted to simulate 20-percent wear.

4. The brake system shall be maintained in such a manner that the brake shall bring the equipment to a complete stop within the distances shown on the curve in figure 23 or stop rotation of all breaking wheels within these distances. This determination shall be made by mine inspectors during routine underground inspections; therefore, allowances must be made for slippery roadways.

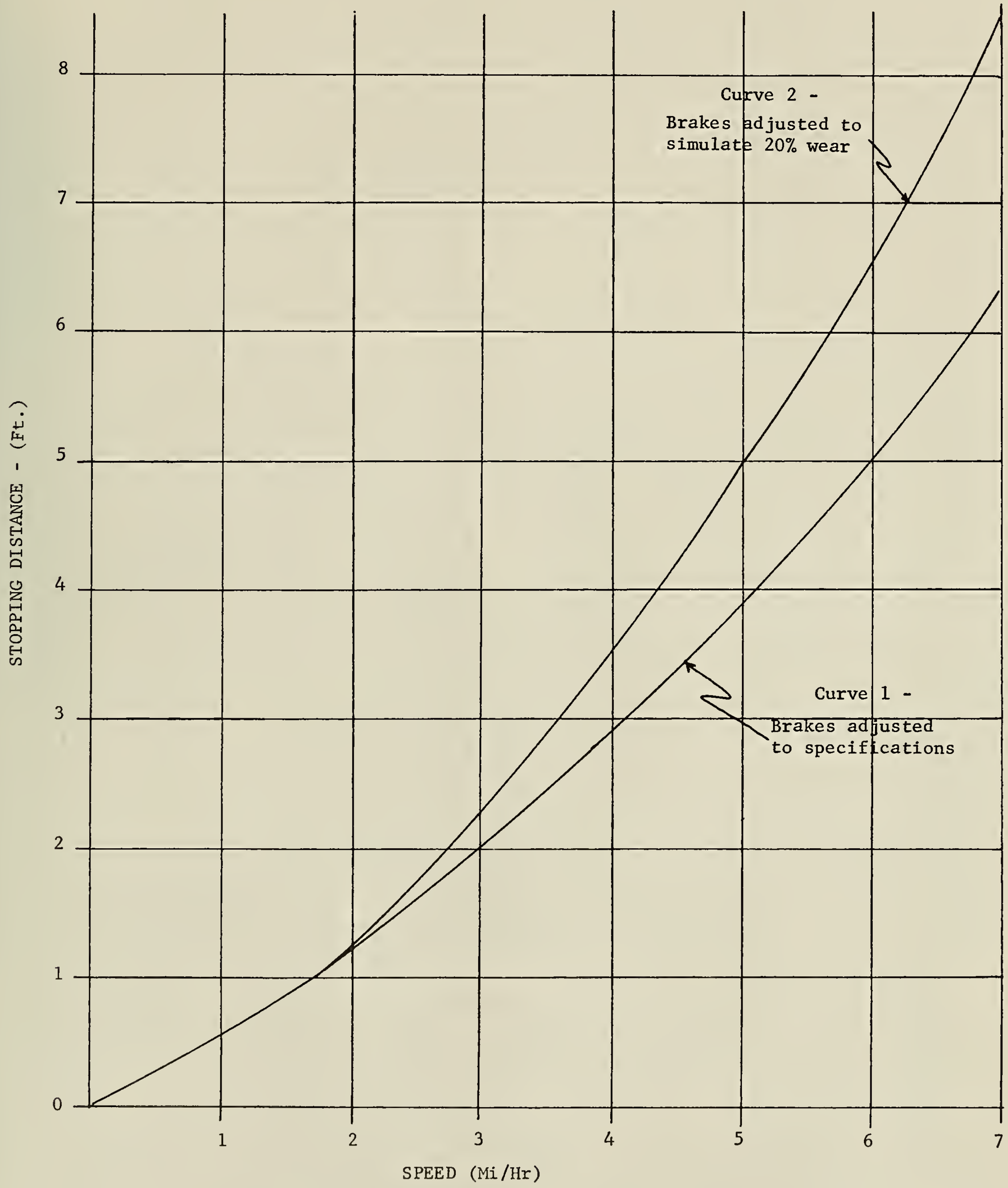

FIGURE 23. - Automatic emergency brake stopping performance.

5. After the brake is engaged, the brake shall remain engaged and shall hold the fully-loaded vehicle on a 20-percent grade until released by an operator, despite any contraction of brake parts, exhaustion of the source of energy, or leakage of any kind.

6. The emergency stopping brake, the parking brake, and the service brake may use common components. However, failure of a common component (with the exception of the brake disk), shall not reduce the effectiveness of the vehicle's stopping capability below the service braking system's stopping capability.

7. Provisions shall be made to allow the automatic parking brake to be manually released to permit moving the machine to a safe location during maintenance operations.

8. Rubber-tired, self-propelled, electric face equipment, with a driving mechanism that precludes accidental movement of the vehicle when parked, shall not be required to be provided with an automatic brake. This is intended to exclude hydraulically trammed machines that are controlled by self-centering levers. This does not exclude rubber-tired cutting machines that are equipped with a transmission that can be placed in neutral.

Investigations leading to approval will be undertaken by MESA only pursuant to receiving a written application. The application, accompanied by all necessary drawings, specifications, descriptions, and related materials as specified, shall be submitted to MESA, Approval and Testing, Pittsburgh Technical Support Center, 4800 Forbes Avenue, Pittsburgh, Pa. 15213.

Drawings will be furnished that describe the brake system, including components. A general arrangement drawing of the mining machine, showing the routing and location of brake system components on the machine, will be provided.

Complete vehicle characteristics will be specified including model identification, maximum vehicle speed, maximum loaded weight, gear reduction between the brake application point and the wheels, loaded tire radius, brake friction radius, and hydraulic system operating pressure.

Brake system characteristics will be specified, including friction material identification and brake system operating pressures. Approval and Testing personnel will evaluate the data provided and notify the applicant if tests or additional information will be required.

When it has been determined that the vehicle braking system has met the requirements, the applicant will be notified by Approval and Testing. The applicant will then install a metal tag in the operator's compartment or operating position that states "Meets MESA Brake Requirements, File No. ______".

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